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February 1972

NAS ADVISORY COMMITTEE ON TECHNOLOGICAL INNOVATION AND MONITORING

PROGRESS REPORT

I. BACKGROUND AND RATIONALE

One of the key questions in the economic and social development of many countries is whether there are new technological approaches that may accelerate such development. While a developing country is generally well aware of the problems it faces in the process of development, it frequently is not in the position to avail itself of all the possibilities that technology can offer for the solution of these problems. These possibilities involve the entire spectrum of technologies--not only the high technologies of which a developing country is frequently well aware, but also, in many ways even more important, the low and middle technologies that are likely to have a capillary impact on the country's development. These technologies may be latent or be utilized in a different fashion in the U.S. or other developed countries, because of the different economic or social conditions. For instance, machine tools or principles of energy generation that are not economical for the U.S. may be very suitable for a country with less expensive manpower or with greater energy scarcity or poorer energy distribution networks.

While a large number of national and international bodies are currently concerned with the problem of technology for developing countries, most of them are generally concerned with complex technology (e.g., UNIDO, NASA) or with the strategy for technological development and with the transfer of existing technologies (e.g., OECD), or with providing information for the solution of relatively small technological problems (VITA). The problem of how to identify and transfer innovative intermediate technologies--and how to foster the related research and development activities--that may make important contributions to developing countries remains a very major gap in the spectrum of assistance that developed nations are providing.

II. THE ADVISORY COMMITTEE ON TECHNOLOGICAL INNOVATION AND MONITORING

To respond to this need, an Advisory Committee on Technological Innovation and Monitoring was set up at the end of July 1971 by the Board on Science and Technology for International Development, at the request of the Agency for International Development, with the approval of the Governing Board at its April meeting.

The program supervised by this Committee has two specific objectives: 1) The generation of ideas for innovative applications of present-day technological developments to immediate problems of developing countries; 2) The identification of areas of research where concerted effort can drastically shorten the time lag characteristic of the normal progression of scientific advance to potential application.

The membership of the Committee is as follows:

Professor George Bugliarello, Dean of Engineering
University of Illinois, Chicago Circle
(Chairman)

Dr. Mahbub ul Haq, Senior Adviser
International Bank for Reconstruction and Development

Professor E. R. Pariser, Senior Research Scientist
Department of Nutrition and Food Science
Massachusetts Institute of Technology

Dr. Charles A. Rosen, Manager
Artificial Intelligence Group, Information Sciences Laboratory
Stanford Research Institute

Professor Stanislaw Ulam, Department of Physics
University of Colorado

For its first formal meeting on September 27, 1971 in Washington, D.C., the Committee met with the Foreign Secretary, Dr. Harrison Brown for discussion of its general objectives. A second meeting was held on December 15, 1971 in Chicago, and the Committee plans to meet regularly at two-month intervals.

III. GUIDING CRITERIA

The ideas and projects that the program intends to foster to achieve its objectives must be compatible with the following criteria:

1. They must have the potential to accelerate the development of one or more developing countries.
2. They must directly involve science or technology as the major component.
3. They must be beneficial in terms of human needs and values, and they should not overlook cultural aspects.
4. They must be non-exploitive of any country by another or of any class by another.
5. They must be innovative (consulting firms can better handle conventional technologies).

6. They must not be projects that would, or could, otherwise be developed for proprietary interests by a profit-making group.

7. The solutions should be realistically implementable, and the proposals should include plans for implementation.

IV. MODE OF OPERATION

The approach evolved by the Advisory Committee to guide its operation can be characterized as a mixture of orderly search and serendipity; the initial endeavor of the Committee has been to organize itself so as to make this possible and fruitful.

The core around which the Committee operates is, in principle, the progression from 1) initial idea exploration by the Committee to 2) ad hoc advisory group studies to 3) in-depth study by expert panels* to 4) project recommendation. This progression, however, is altered to suit particular cases, and the value of maintaining flexibility has been amply justified by experience thus far. For example, of the subjects which are currently being studied by the Committee, two originated with the Committee, two are being pursued through the ad hoc advisory group stage, two by-passed this stage completely, and one is being conducted under another Academy Board with Committee overview.

A significant characteristic in the operation of the Committee is the breadth of the backgrounds of its members, which ranges from economics to engineering to mathematics to food technology. Equally important to the operation of the Committee, as its activities unfold, is the participation of members from developing countries. How such participation could be more fruitfully achieved is exemplified by the results of the participation of the Committee in the IVth Brazil-U.S. Workshop of the National Academy of Sciences, which was held in Washington in November. A presentation of the goals and mode of operation of the Committee elicited considerable interest on the part of the Brazilian participants and lead to a strong recommendation by the Workshop of a formula for formal Brazilian representation on the Committee and an urgent request that the Committee hold a meeting in Brazil in the very near future.

The Committee is also planning to experiment with special panels on innovative research that would provide vehicles for generation and exchange of innovative ideas on an informal "brainstorming" basis by diversified groups that have the opportunity of meeting frequently on a regional (U.S.) basis. The first such group is being organized on the West Coast with the assistance of Dr. Carl Djerassi (Board on Science and Technology for International Development) and is tentatively scheduled to meet in February.

*These panels are organized and the studies pursued with consultation with appropriate NRC Boards and Committees.

V. SPECIFIC CURRENT AND PROPOSED ENDEAVORS

The Committee and its staff have a number of endeavors currently under way. These include studies of:

1. Potential of Ferro-Cement for boatbuilding and other construction
2. Development and use of inexpensive and effective roofing materials and techniques
3. Non-food uses of unutilized proteins
4. Low power sources to meet communications needs in villages in underdeveloped countries
5. Collection and publication of "102 Specific Technical Problems of Interest to Developing Countries"
6. Use of larvicidal techniques and materials for mosquito control.

A description of each one of these projects follows. Additional projects are in a less developed, exploratory phase.

1. Potential of Ferro-Cement for boatbuilding and other construction

Background

Fish is considered one of the most important natural resources in many developing countries because of its contribution to the protein level of local diets. Often, however, because of a shortage of suitable fishing vessels, the potential fish catch is rarely realized.

A possible solution to this problem is a method for small boat construction using multiple layers of chicken wire impregnated with concrete which is now gaining momentum in a number of countries in the developed world. This method may have promise for developing countries as well, for it uses materials which are generally available there, it requires no high technology, and it produces boat hulls which are remarkably resistant to corrosion under tropical environments. The literature on these ferro-cement boats suggests that they can be produced at low-cost and under very primitive conditions; indeed the Peoples' Republic of China has produced thousands of them in recent years.

Initial Steps

The Advisory Committee has initiated a study of the potential use of ferro-cement technology in international development. An expert panel is being organized, the Chairman has been selected,

and the panel is scheduled to hold its first meeting in the Spring.

The study will investigate the potential of ferro-cement for both boatbuilding and other construction (silos, roofs, walls, pipes, etc.). The results of the study are intended for use by AID and will also be distributed to appropriate organizations and individuals in developing countries. As a result of the intense interest already shown in the preliminary staff survey, it is anticipated that the panel's report will be of even greater interest to development agencies and responsible officials in developing countries.

2. Development and use of inexpensive and effective roofing materials and techniques

Background

Problems of roofing constitute the greatest construction obstacle to the production of housing in the less-developed tropical areas of the world. The Agency for International Development annually commits considerable sums of money for the construction of low-cost housing in less-developed countries, a major fraction of which is for purchase of roofing materials. At the request of AID, and with the approval of the Governing Board, the Board on Science and Technology for International Development, through the Advisory Committee on Technological Innovation and Monitoring is collaborating with the Building Research and Advisory Board to explore the feasibility of initiating or stimulating a program of research and development in this area, and outlining such a program should its feasibility be established.

Initial Steps

The Building Research Advisory Board, in cooperation with the staff of the ACTIM, is organizing a ten-man advisory panel of designers, builders, market analysts and building material developers and is providing the necessary staff to carry out the study.

The names of candidates for this Advisory Panel have been suggested by members of the Building Research Advisory Board, the Federal Construction Council, Building Research Institute, Building Industry Manufacturers Research Council, United States National Committee/Council for International Building Research and Documentation, and the United States Department of Housing and Urban Development. It is anticipated that selection of the Advisory Panel will be completed by April 1972.

Background data and information relevant to the subject of low-cost roofing are being assembled by the staff and will be disseminated before the first meeting of the Panel which is tentatively scheduled for early summer 1972. The Panel will meet twice, first to map out the direction of the exploratory effort and the second time to consolidate recommendations. These recommendations will be presented to BOSTID for transmittal to AID and, if further in-depth research is feasible, the Panel will ouline the future steps that AID should take.

It is anticipated that this study will identify promising materials, material combinations, and promising areas of research, and will set guidelines for a more comprehensive, perhaps worldwide survey. The report will be intended for use by AID and other agencies, such as CARE and UNIDO, which are concerned with the construction of low-cost housing in tropical countries.

This is the first such project of its kind in this field, a field which has been identified as a priority area in the "World Plan of Action for the Application of Science and Technology to Development." The combination of BRAB's experience and contacts with the construction industry and building research stations worldwide, and BOSTID's experience with the concerns, priorities and resources of developing countries respectively, represents a significant effort in this critical area.

3. Non-food uses of unutilized proteins

Background

During the years since the end of World War II, a large number of projects have been initiated to develop, manufacture and distribute a variety of protein supplements to improve the nutritive value of deficient diets. These projects have been sponsored, conducted and/or supervised by the United Nations, private industries, single individuals, foundations, and foreign aid agencies of governments, using a variety of funds as financial support and many products as starting materials. In spite of these considerable efforts, only a handful of the numerous high-protein low-cost food products that were developed ever reached the people for whom the foods were originally intended, largely because production did not appear to be commercially profitable.

As a consequence of this situation and in view of the realization that many sources of protein remain completely unutilized, the Advisory Committee on Technological Innovation

and Monitoring is investigating the possibility of using such protein sources for non-food products for which markets are known presently to exist.

Initial Steps

An ad hoc expert panel has been formed to assist the Committee by exploring the feasibility and/or advisability of organizing a formal study of the problem. The panel, composed of academic and industrial experts, will meet in Cambridge late in January under the chairmanship of Prof. E. R. Pariser, member of the Advisory Committee.

The group will be concerned, among other things, with:

a) Manufacturing processes in which proteins are produced as by-products and largely wasted at present, as in the utilization and processing of coconut, tobacco, and castor oil seed for example.

b) Commercial processes for which specific proteins are required as chemical reactants or ingredients; this approach will be taken in the hope of matching known raw material requirements with known raw material sources, such as the formulation of foaming agents and stabilizers, packaging and building materials.

c) Processes which require chemical compounds uniquely or abundantly present in proteins, such as certain amino acids that are needed for the manufacture of pharmaceuticals, for instance.

An example of the kind of development that the group's discussions might catalyze is the investigation of the industrial utilization of chitin initiated by the Sea Grant Program of the Department of Commerce. This project was initiated in response to a recent Government regulation prohibiting the dumping of chitin (the major chemical component of the exo-skeleton of crustaceans and a voluminous and stable waste product of shrimp. crab and lobster processing plants) into the sea. (The search has already produced interesting results; for example, a simple chemical modification of the chitin yields a new product with many attractive structural properties promising to be very useful for a large number of existing industrial processes.)

4. Electrical power for villages in underdeveloped countries

Background

An inexpensive reliable power supply for simple communications

equipment, including television receivers designed with lower power requirements, is an important need for underdeveloped countries in general. A particularly urgent need for a small low-power generator suitable for use in remote villages has arisen in the Satellite Instructional Television program, based on a synchronous satellite to be launched in 1973 by NASA, with TV broadcast capabilities to cover all of India.

Initial Steps

Dr. Charles A. Rosen, member of the Advisory Committee, accepted the task to initiate the exploration of the problem, as a preliminary step toward the possible establishment of one or more consultative ad hoc expert committees.

Contacts were initiated with key Indian personnel associated with the satellite project to determine status and requirements. Dr. B.S. Rao, Director of the Electronic Systems Division of the Indian Space Research Organization, has indicated that the problem has not been satisfactorily solved and that he would welcome formation of a task force of scientists and engineers to investigate and recommend innovative solutions.

Dr. Pramod Kale, Indian representative of the program stationed at Goddard Space Flight Center, NASA, has actively studied the problem and has supplied information on the presently-known power requirements for the TV receiver system, as well as other information regarding fuel sources, availability of equipment, Indian manufacturing capabilities, etc. In brief, their present plan is to power specially designed battery-operated TV sets with commercial lead-acid storage batteries (24V) which are kept charged by auxiliary equipment. They expect to run the TV system approximately four hours a day, requiring from 200-240 watt-hours for this period. With losses taken into account, a battery charging system must supply 350 watt-hours daily. If the charging system functions 20 hours a day it thus must be capable of generating 17.5 watts continuously. Its manufacturing cost should preferably be below $100 but may be higher based on trade-off factors, such as reliability, low maintenance, ease of manufacture in India, etc. The Indian group has considered motor-generator sets, human- and animal-powered generators, and devices which are inductively coupled to high-tension power lines (where applicable). They have also had studies made on the applicability of solar energy conversion, thermo-electric generators and other conversion methods, but have not been able to find a commercially available system which meets the requirements at an acceptable cost per unit, and with the required reliability and ease of maintenance.

There are several possible conversion methods which should

be investigated in some depth. The Russian Army widely used a thermo-electric generator for low-power signalling purposes. It was capable of delivering 5 watts, operating off the waste heat of a kerosene lamp. From our present knowledge it was a relatively inexpensive device but may have had some reliability problems. (More detailed information regarding this device is available in this country and will be obtained.) Contacts are being made with several United States companies who appear to have expertise in thermo-electric generators, developed to operate under constraints quite different from ours; possibly their fabrication methods may be used to good advantage for the low-power system we are seeking.

Dr. Kale's indication that kerosene is not only available almost everywhere in India but is considered inexpensive enough to provide fuel for this purpose has raised the possibility of a second method of generation worth investigating, namely a mass-produced gas turbine driving a permanent magnet electric generator, with emphasis on low cost and reliability. If high efficiency of conversion can be sacrificed it may be possible to develop a small rugged system using mass production casting and other metal fabricating techniques. This approach has not been explored as yet, and would require at least a first "reading" by experts.

In summary, the evidence at hand indicates that:

1) There is an unsolved problem in supplying modest amounts of electrical power to remote villages in underdeveloped countries for radio, television, and other communications apparatus.

2) Kerosene-driven thermo-electric and hot air engine generators are potentially capable of satisfying the requirements, although other methods, such as inexpensive solar conversion, are not ruled out.

On this basis, an ad hoc committee of experts will be formed to further sift and refine the evidence at hand, and assist the Committee by exploring the feasibility of organizing a more formal study of the problem and search for innovative solutions.

5. "102 Problems"

Background

The organization and publication of a series of volumes of specific technological problems of interest to developing countries would be very useful and valuable from many points of view:

a. It would provide a series of compendia, in specific fields, of real problems of practical concern to developing nations which, as a source of research topics, could stimulate the interest and involvement of researchers and graduate students, both at home and abroad, in technical assistance.

b. It would serve as a rational filter mechanism for screening the ever increasing numbers of problems which are being brought to the attention of the Committee and staff, and would provide a needed data base for the Committee's activities.

c. It would provide a mechanism for diffusion of technological information to the scientific community and to the public at large.

d. It would serve as one mechanism which would enable the NAS to become a catalyst in applying the technological abilities of the U.S. to problems of development.

e. By incorporating solutions and the names of their developers in subsequent issues, it would serve to increase communication within the developing world and facilitate wider application of results and discourage duplication of effort.

Initial Steps

Fruitful fields to be covered and techniques for gathering suggestions have been considered. A pilot study is being prepared in the fields of food technology and power sources. This pilot study will include problems and solutions, thus serving the dual function of helping to formalize the program aims and of diffusing information being collected by the committee staff on solutions and potential solutions to technological problems.

The experimental Special Panel on Innovative Research (referred to in Section IV) being organized on the West Coast will be asked to provide suggestions and cooperation in gathering ideas for the pilot study.

6. Use of larvicidal techniques and materials for mosquito control

Background

Preliminary investigation by the Committee's staff indicates that many entomologists feel that the time is ripe for a new look at mosquito control in terms of innovative techniques which are

not being explored by agencies concerned with problems of public health in developing countries. For example, both recent and older work indicate potential utility for the use of garlic extract or algae extracts as larvicides, carnivorous aquatic plants as consumers of larvae, sticky-coated seeds to trap and drown larvae, and other methods of biological control.

Initial Steps

The Advisory Committee, through its staff, has initiated the formation of an ad hoc expert panel which will counsel the Committee on the value of further endeavors in this field and recommend the most effective course of action. The panel has been selected and it will meet within the next few weeks.